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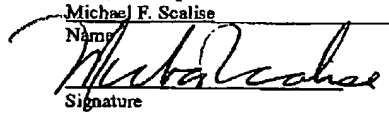
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:		O'Brien et al.
Serial No.	:	10/719,632
Filed	:	November 21, 2003
For	:	Nanotube Coatings For Implantable Electrodes
Examiner	:	L. Faulcon, Jr.
Group Art Unit	:	3762

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APPEAL BRIEF UNDER 37 CFR 1.192

Sir:

In response to the Office Action dated April 6, 2006, the Applicants file this Appeal Brief:

07/11/2006 MBINAS 00000002 10719632
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Table of Contents

Real Party in Interest

The real party in interest is Greatbatch-Hittman, Inc., 9190 Red Branch Road, Columbia, Maryland 21045.

Related Appeals and Interferences

There are no related appeals and interferences.

Status of Claims

Claims 1 to 26 are rejected. There are no other claims on appeal.

Status of Amendments

No amendment has been filed subsequent to the final rejection dated April 6, 2006.

Summary of Claimed Subject Matter

1. An implantable electrode (page 1, lines 8-11) intended to be imbedded in body tissue (page 1, lines 13-18), which comprises:

a) a substrate (page 5, lines 4-6);

b) a biocompatible and electrically conductive catalyzing coating supported on the substrate (page 5, lines 6-16); and

c) a multiplicity of carbon-containing nanotubes (page 3, lines 12-14), each comprising a sidewall having a length extending to first and second ends (page 3, lines 14-18), wherein a substantial number of the nanotubes are covalently bonded to the coating (page 4, lines 1-3) at only their first end (page 3, lines 25-27 and Fig. 2B) exhibiting relatively low polarization (page 4, lines 3-5) with respect to the second, free end, and wherein if there are nanotubes covalently bonded to the substrate at both their first and second ends (page 3, lines 25-27 and Fig. 2B), the sidewall of those nanotubes exhibits relatively low polarization with respect to the first and second ends (page 4, lines 3-5), wherein with the electrode imbedded in body tissue (page 1, lines 13-16), electrical energy (page 1, lines 11-13) is transferable through the substrate, the catalyzing coating and then from exposed portions not covalently bonded to the coating of the multiplicity of nanotubes to the body tissue in a low energy loss (page 1, lines 22-23) manner suitable for an implantable electrode.

11. A method for providing an implantable electrode (page 1, lines 8-11), comprising the steps of:

a) providing a substrate (page 5, lines 4-6);

b) coating a catalytic material selected from the group consisting of carbon, nitrogen-doped carbon, tantalum, titanium, zirconium, iridium, platinum, and niobium (page 5, lines 9-10) or a nitride, a carbide, a carbonitride, and an oxide thereof (page 5, lines 10-13) on the substrate;

c) heating the coated substrate (page 6, lines 14-19);

d) contacting the heated substrate with a flowing hydrogen-containing gas stream (page 6, lines 19-21) to thereby provide a multiplicity of carbon-containing nanotubes (page 3, lines 12-14) covalently bonded to the coated substrate (page 4, lines 1-3), the nanotubes comprising a sidewall having a length extending to first and second ends (page 3, lines 14-18), wherein a substantial number of the nanotubes are covalently bonded to the substrate at only their first end (page 3, lines 25-27 and Fig. 2B) exhibiting relatively low polarization (page 4, lines 3-5) with respect to the second, free end, and wherein if there are nanotubes covalently bonded to the substrate at both their first and second ends (page 3, lines 25-27 and Fig. 2B), the sidewall of those nanotubes exhibits relatively low polarization with respect to the first and second ends (page 4, lines 3-5); and

e) wherein with the electrode imbedded in body tissue in a functional manner (page 1, lines 13-15), electrical energy (page 1, lines 11-13) transfers

through the substrate, the catalyzing coating and then from exposed portions not covalently bonded to the coating of the multiplicity of nanotubes to the body tissue in a low energy loss (page 1, lines 22-23) manner suitable for an implantable electrode.

14. A method of providing an implantable electrode (page 1, lines 8-11), comprising the steps of:

a) providing a substrate (page 5, lines 4-6);

b) providing nanotubes mixed with a binder precursor selected from chloroiridic acid, chloroplatinic acid, titanium (IV) chloride, zirconium (IV) chloride, niobium (V) chloride, and tantalum (V) chloride in a solvent (page 7, lines 25-31);

c) contacting the binder precursor to the substrate (page 8, lines 3-8);

d) converting (page 8, lines 10-21) the binder precursor to a coating on the substrate having a multiplicity of nanotubes (page 3, lines 12-14) covalently bonded thereto (page 4, lines 1-3), the nanotubes comprising a sidewall having a length extending to first and second ends (page 3, lines 14-18), wherein the nanotubes are either covalently bonded to the substrate at only their first end (page 3, lines 25-27 and Fig. 2B) or they are covalently bonded to the substrate at both their first and second ends (page 3, lines 25-27 and Fig. 2B) so that the sidewall of the nanotubes exhibiting relatively low polarization (page 4, lines 3-5) with respect to the covalently bonded end or ends is

directly contactable by body tissue (page 4, lines 3-5); and

d) wherein with the electrode imbedded in body tissue in a functional manner (page 1, lines 13-15), electrical energy (page 1, lines 11-13) transfers through the substrate, the catalyzing coating and then from exposed portions not covalently bonded to the coating of the multiplicity of nanotubes to the body tissue in a low energy loss (page 1, lines 22-23) manner suitable for an implantable electrode.

20. A method for providing an implantable electrode (page 1, lines 8-11), comprising the steps of:

a) providing a substrate (page 5, lines 4-6);

b) coating a carbonaceous catalytic material on the substrate (page 5, lines 17-18);

c) heating the carbonaceous coated substrate (page 6, lines 14-19);

d) contacting the heated substrate with a flowing hydrogen-containing gas stream (page 6, lines 19-21) to thereby provide a multiplicity of carbon-containing nanotubes (page 3, lines 12-14) covalently bonded to the carbonaceous coated substrate (page 4, lines 1-3), the nanotubes comprising a sidewall having a length extending to first and second ends (page 3, lines 14-18), wherein a substantial number of the nanotubes are covalently bonded to the substrate at only their first end (page 3, lines 25-27 and Fig. 2B) exhibiting relatively low polarization (page 4, lines 3-5) with respect to the second, free end, and wherein if

there are nanotubes covalently bonded to the substrate at both their first and second ends (page 3, lines 25-27 and Fig. 2B), the sidewall of those nanotubes exhibits relatively low polarization with respect to the first and second ends (page 4, lines 3-5); and

e) wherein with the electrode imbedded in body tissue in a functional manner (page 1, lines 13-15), electrical energy (page 1, lines 11-13) transfers through the substrate, the catalyzing coating and then from exposed portions not covalently bonded to the coating of the multiplicity of nanotubes to the body tissue in a low energy loss (page 1, lines 22-23) manner suitable for an implantable electrode.

25. A method for providing an implantable electrode (page 1, lines 8-11), comprising the steps of:

a) providing a substrate (page 5, lines 4-6);

b) coating a catalytic material selected from the group consisting of carbon, nitrogen-doped carbon, tantalum, titanium, zirconium, iridium, platinum, and niobium (page 5, lines 9-10) or a nitride, a carbide, a carbonitride, and an oxide thereof (page 5, lines 10-13) on the substrate;

c) subjecting the coated substrate to a plasma assisted chemical vapor deposition process (page 7, lines 1-8) containing a flowing hydrocarbon-containing gas stream (page 7, lines 9-15) to thereby provide a multiplicity of carbon-containing nanotubes (page 3, lines 12-14) covalently bonded to the coated substrate (page 4, lines 1-3), the nanotubes

comprising a sidewall having a length extending to first and second ends (page 3, lines 14-18), wherein a substantial number of the nanotubes are covalently bonded to the substrate (page 4, lines 1-3) at only their first end (page 3, lines 25-27 and Fig. 2B) exhibiting relatively low polarization (page 4, lines 3-5) with respect to the second, free end, and wherein if there are nanotubes covalently bonded to the substrate at both their first and second ends (page 3, lines 25-27 and Fig. 2B), the sidewall of those nanotubes exhibits relatively low polarization with respect to the first and second ends (page 4, lines 3-5); and

d) wherein with the electrode imbedded in body tissue in a functional manner (page 1, lines 13-15), electrical energy (page 1, lines 11-13) transfers through the substrate, the catalyzing coating and then from exposed portions not covalently bonded to the coating of the multiplicity of nanotubes to the body tissue in a low energy loss (page 1, lines 22-23) manner suitable for an implantable electrode.

Grounds of Rejection to Be Reviewed On Appeal

1. Whether claims 1 to 5 and 10 are unpatentable under 35 USC 103(a) over Malonek et al. (U.S. Patent No. 6,292,704) in view of Lieber et al. (U.S. Pub. No. 2002/0117659).

2. Whether claims 6, 7, 14 to 19, 25 and 26 are unpatentable under 35 USC 103(a) over Malonek et al. in view of Lieber et al. as applied to claims 1 to 5 and 10 above, and further in view of Smalley et al. (U.S. Pub. No. 2002/0085968).

3. Whether claims 8, 9, 11 to 13 and 20 to 24 are unpatentable under 35 USC 103(a) over Malonek et al. in view of Lieber et al. as applied to claims 1 to 7, 10, 14, 15, 18, 19, 25 and 26 above, and further in view of Croci et al. (U.S. Pub. No. 2004/0151835).

Arguments

1. Claims 1 to 5 and 10 are rejected under 35 USC 103(a) as being unpatentable over Malonek et al. (U.S. Patent No. 6,292,704) in view of Lieber et al. (U.S. Pub. No. 2002/0117659). Malonek et al. teaches mycardial electrodes made from a substrate material, such as platinum-iridium, coated with an inert, high-capacitance material, such as iridium oxide, titanium nitride, pyrolytic carbon, and activated carbon.

As discussed in paragraph 0016, Lieber et al. generally relates to "a nanowire sensor device comprising a semiconductor nanowire and a binding partner having a specificity for a selected moiety. The nanowire has an exterior surface formed thereon to form a gate electrode. The nanowire also has a first end in electrical contact with a conductor to form a source electrode and a second end in contact with a conductor to form a drain electrode."

At paragraph 0062, Lieber et al. describe that the sensor device is made possible since "the nanowires are functionalized at their surface, or in close proximity to their surface. In one particular case, functionalization (e.g., with a reaction entity), either uniformly or non-uniformly, permits interaction of the functionalized nanowire with various entities, such as molecular entities, and the interaction induces a change in a property of the functionalized nanowire, which provides a mechanism for a nanoscale sensoring device."

Paragraph 0063 states that "a 'nanotube' is a nanowire that has a hollowed-out core . . ."

At paragraph 0064, Lieber et al. teach that "a nanowire or nanowires preferably forming part of a system [is] constructed and arranged to determine an analyte in a sample to which the nanowire(s) is exposed. 'Determine', in this context, means to determine the quantity and/or presence of the analyte in the sample. Presence of the analyte can be determined by determining a change in a characteristic in the nanowire, typically an electrical characteristic or an optical characteristic. E.g. an analyte causes a detectable change in electrical conductivity of the nanowire or optical properties. In one embodiment, the nanowire includes, inherently, the ability to determine the analyte. The nanowire may be functionalized, i.e. comprising surface functional moieties, to which the analytes binds and induces a measurable property change to the nanowire."

This binding is further described in paragraph 0068 as the "binding may be by one or more of a variety of mechanisms including, but not limited to ionic interactions, and/or covalent interactions, and/or hydrophobic interactions, and/or van der Waals interactions, etc." (Emphasis added.)

Construction of the sensor is described at paragraph 0121 where "[a]ssembly, or controlled placement of nanowires on surfaces after growth can be carried out by aligning nanowires using an electrical field. An electrical field is generated between [the source and drain] electrodes, nanowires are positioned between the electrodes (optionally flowed into a region between the electrodes in a suspending fluid), and will align in the electrical field and thereby can be made to span the distance between and contact each of the [source and drain] electrodes."

In that respect, Fig. 1 of Lieber et al. illustrates a nanoscale detector 10 comprised of a single nanowire 38 positioned above the upper surface 18 of a substrate 16. A portion of the sidewall of the nanowire 38 is within the sample exposure region 30. Source and drain electrodes 36 connect the nanowire 38 to electrical connections 22 that, in turn, connect to a detector for measuring a change in an electrical or other property of the nanowire.

A specific sensor embodiment is described in paragraph 0157 with respect to Fig. 16a. There, Lieber et al. teach that "the nanowire sensor of the invention comprises a single molecule of doped silicon 50. The doped silicon is shaped as a tube, and the doping can be n-doped or p-doped. Either way, the doped silicon nanowire forms a high resistance semiconductor material across which a voltage may be applied. The exterior surface and the interior surface of the tube will have an oxide formed thereon and the surface of the tube can act as the gate 52 of an FET device and the electrical contacts at either end of the tube allow the tube ends to acts as the drain 56 and the source 58. In the depicted embodiment the device is symmetric and either end of the device may be considered the drain or the source. For purpose of illustration, the nanowire of FIG. 16a defines the left-hand side as the source and the right hand side as the drain. FIG. 16a also show (sp) that the nanowire device is disposed upon and electrically connected to two conductor elements 54 [at its sidewall adjacent to the ends connected to the drain 56 and source 58 electrodes]."

Finally, paragraph 0159 teaches that "[e]lements of interest within the sample can contact the surface of the

nanowire device and, under certain conditions, bind or otherwise adhere to the surface." (Emphasis added.")

It is clear that Lieber et al. contemplated the surface of the nanowire where covalent bonding of an analyte with a moiety occurs as being distinct from the opposed ends connected to the source and drain electrodes. The surface to which the analyte of interest binds is not the ends connected to the source and drain electrodes. However, the examiner would have one believe that those portions of the ends not directly connected to the source and drain electrodes constitute a portion of the nanowire active surface. On page 2 of the final rejection dated April 6, 2006, the "Examiner takes the position that Lieber et al. teaches of a nanowire/nanotube that has a 'sidewall having a length extending to first and second ends' (figure 1b and 16a). Examiner also takes the position that the covalent bond as taught by Lieber et al. (paragraphs 68, 72) extends on the 'surface' of the nanotube (paragraphs 158-160) to at least a portion of the nanotube 'end' (figure 16) as defined by the applicant."

Figs. 16a to 16d are described in the Brief Description of the Drawings section of the Lieber at al. application as being depictions of a nanowire sensor. In other words, the nanowire is drawn grossly out of scale in order to show the sensor and how an analyte might bind to a moiety on its surface. In Fig. 16a, the line leading from the source electrode 58 to the left end of the nanowire seems to end at an inner surface of the tube.

Paragraph 0063 states that "a 'nanowire' is an elongated nanoscale semiconductor which, at any point along its length, has at least one cross-sectional dimension and, in some

embodiments, two orthogonal cross-sectional dimensions less than 500 nanometers, preferably less than 200 nanometers, more preferably less than 150 nanometers, still more preferably less than 100 nanometers, even more preferably less than 70, still more preferably less than 50 nanometers, even more preferably less than 20 nanometers, still more preferably less than 10 nanometers, and even less than 5 nanometers. In other embodiments, the cross-sectional dimension can be less than 2 nanometers or 1 nanometer. In one set of embodiments the nanowire has at least one cross-sectional dimension ranging from 0.5 nanometers to 200 nanometers. Where nanowires are described having a core and an outer region, the above dimensions relate to those of the core. The cross-section of the elongated semiconductor may have any arbitrary shape, including, but not limited to, circular, square, rectangular, elliptical and tubular. Regular and irregular shapes are included."

The point is that drawing Figs. 16a to 16d are not to scale. The dimensions discussed above would not leave much, if any, "surface area" at an end of the nanotube for reaction of a surface moiety with an analyte. Simply because the leads for the respective electrodes are drawn as ink lines to an enlarged end of the nanowire does not mean that one skilled in the art would have understood that the ends of a nanowire can serve as an active "surface". Figs. 16c and 16d clearly show the moiety binding to the outer surface of the nanowire, and not at an end.

In contrast, the nanotubes of the applicants' claimed invention each comprise a length between first and second ends. Substantial numbers of them are covalently bonded at only their first end to a biocompatible and electrically

conductive coating provided on a substrate. An example is the spiky carbon whisker structures discussed at page 7, lines 9 to 15 and shown in Figs. 2A and 2B of the specification. However, as described at page 3, lines 12 to 30, there are also nanotubes covalently bonded to the substrate at both their first and second ends. This has less to do with design and more to do with how nanotubes behave when used to form the claimed electrode. Regardless, in the applicants' claimed invention with the nanotubes having their end or ends covalently bonded to the catalyzing coating on the substrate, a free portion of the nanotubes exhibiting relatively low polarization (page 4, lines 3 to 5) with respect to the covalently bonded end or ends is directly contactable by body tissue. Electrical energy is then transferable through the substrate, the conductive catalyzing coating and the multiplicity of nanotubes in a low energy loss manner (page 1, lines 7 to 22) suitable for an implantable electrode.

This raises a second problem with the Examiner's reasoning. Neither of the applicants' claimed nanotube embodiments would function as a sensor according to Lieber et al. where the opposed nanotube ends are either at a source or a drain potential. In the majority of the claimed nanotubes having only one end covalently bonded to the substrate, the opposed end is free. In that case, it is not possible to have a sensor. Providing the nanotube having a free end would not make a sensor circuit.

For the other nanotubes having both of their ends covalently bonded to the substrate, the opposed ends are each at the potential of the substrate. In a sensor, a change in electrical potential between the source and drain electrodes indicates the presence of an analyte bonded to the nanotube

sidewall. With both nanotube ends connected to the same substrate surface, there cannot be a change in potential from one end to the other and, therefore, no sensor.

Another way of looking at this is that the source and drain electrodes are equivalent to first and second substrates. Providing a nanotube bridging between spaced apart substrates is not structurally similar to having "a multiplicity of carbon-containing nanotubes . . . covalently bonded to the coating" supported on the substrate. In the claimed invention, the nanotubes are supported on a shaped "metal substrate" as a stand alone electrode, regardless if it is at one or both of the nanotube ends.

Finally, the Examiner takes the position that "[i]t would have been obvious to modify the lead and methods of Malonek et al. by adhering a multiplicity of carbon-containing nanotubes to the coating for the purpose of strengthening the electrode." Whether the applicants' claimed electrode is inherently stronger than one devoid of nanotubes is beside the point. The distinguishing characteristics is that the claimed nanotubes have either one or both of their ends covalently bonded to a substrate so that "electrical energy is transferable through the substrate, the catalyzing coating [supported thereon] and then from the exposed portions [of the nanotube] not covalently bonded to the coating of the multiplicity of nanotubes to the body tissue in a low energy loss manner suitable for an implantable electrode." Strength is not the issue; low energy loss transmission is.

Accordingly, amended independent claim 1 is patentable over this combination of patent references. Claims 2 to 5 and 10 are allowable as hinging from a patentable base claim.

2. Claims 6, 7, 14 to 19, 25 and 26 are rejected under 35 USC 103(a) as being unpatentable over Malonek et al. in view of Lieber et al. as applied to claims 1 to 5 and 10 above, and further in view of Smalley et al. (U.S. Pub. No. 2002/0085968). Smalley et al. describes a method for producing single-walled carbon nanotubes by supplying carbon vapor to the "live end" of a carbon nanotube maintained in an annealing zone. The live end is where the one or more Group VI or VIII transition metals serving as catalysts are located. Then, the carbon nanotubes grow in length by the catalytic addition of carbon from the vapor to the live ends. This is described in paragraph 0067.

The examiner re-iterates his position that the teachings of Smalley et al. in conjunction with Malonek et al. and Lieber et al. would have taught one skilled in the art "to increase the strength and durability of the electrode . . . since the various types of nanotubes are known for the strength characteristics." Again, whether the applicants' claimed electrode is inherently stronger than one devoid of nanotubes is irrelevant. Instead, the claimed electrode is for the purpose of providing low energy loss transmission into a body tissue being assisted by the associated medical device.

Therefore, as discussed above, independent claim 1 is believed to be patentable over the Lieber et al. reference. Accordingly, claims 6 and 7 are allowable as depending from a patentable base claim. Independent claims 14 and 25 have been amended in a similar manner as claim 1. This means that claims 15 to 19 and 25 are likewise allowable as hinging from patentable base claims.

3. Claims 8, 9, 11 to 13 and 20 to 24 are rejected under 35 USC 103(a) as being unpatentable over Malonek et al. in view

of Lieber et al. as applied to claims 1 to 7, 10, 14, 15, 18, 19, 25 and 26 above, and further in view of Croci et al. (U.S. Pub. No. 2004/0151835). Croci et al. relates to coating carbon nanotubes on a substrate for the manufacture of an election-emitting cathode for a luminescent tube. The surface of a substrate is coated with a catalytic substance, for example a salt of iron, nickel or cobalt. If desired, a layer of titanium is deposited on the substrate to enhance catalyst adhesion. Carbon monoxide, acetylene, methane, ethylene, butane, benzene, and mixtures thereof are suitable carbonaceous compounds that can be decomposed to give carbon nanotubes. The growth of nanotubes is then carried out under a gas stream or under a static atmosphere with the substrate heated to about 300°C to about 1,500°C. Passing an electric current through the conductive substrate preferably does the heating. In Fig. 1 of Croci et al., the substrate is shown as a wire 5 coated over its entire surface by a layer 6 of carbon nanotubes.

Again, claims 8 and 9 are allowable as depending from a patentable base claim 1. Independent claims 11 and 20 contain similar patentable aspects as independent claim 1. This means that claims 12, 13 and 21 to 24 are likewise allowable as hinging from patentable base claims.

Claims Appendix

1. An implantable electrode intended to be imbedded in body tissue, which comprises:

a) a substrate;

b) a biocompatible and electrically conductive catalyzing coating supported on the substrate; and

c) a multiplicity of carbon-containing nanotubes, each comprising a sidewall having a length extending to first and second ends, wherein a substantial number of the nanotubes are covalently bonded to the coating at only their first end exhibiting relatively low polarization with respect to the second, free end, and wherein if there are nanotubes covalently bonded to the substrate at both their first and second ends, the sidewall of those nanotubes exhibits relatively low polarization with respect to the first and second ends, wherein with the electrode imbedded in body tissue, electrical energy is transferable through the substrate, the catalyzing coating and then from exposed portions not covalently bonded to the coating of the multiplicity of nanotubes to the body tissue in a low energy loss manner suitable for an implantable electrode.

2. The electrode of claim 1 wherein the substrate is selected from the group consisting of tantalum, titanium, zirconium, iridium, platinum, and niobium.

3. The electrode of claim 1 wherein the substrate is different than the catalyzing coating and the catalyzing coating is selected from the group consisting of tantalum, titanium, zirconium, iridium, platinum, niobium, carbon, and nitrogen-doped carbon.

4. The electrode of claim 3 wherein the nitrogen in the nitrogen-doped carbon is provided at a concentration of about 1 to about 57 atomic percent.

5. The electrode of claim 1 wherein the coating is selected from the group consisting of a nitride, a carbide, a carbonitride, and an oxide of the group of tantalum, titanium, zirconium, iridium, platinum, and niobium.

6. The electrode of claim 1 wherein the nanotubes are in a form selected from the group consisting of single-wall nanotubes, multi-wall nanotubes, nanotube ropes, carbon whiskers, and combinations thereof.

7. The electrode of claim 1 wherein the nanotubes are of carbon-doped boron nitride.

8. The electrode of claim 1 wherein the nanotubes are characterized as having been grown from a reaction gas selected from the group consisting of acetylene, methyl acetylene-propadiene, and a gas of the paraffin series.

9. The electrode of claim 8 wherein the reaction gas is characterized as having an ammonium addition.

10. The electrode of claim 1 comprising the nanotubes adhering to tantalum coated on a titanium substrate.

11. A method for providing an implantable electrode, comprising the steps of:

a) providing a substrate;

b) coating a catalytic material selected from the group consisting of carbon, nitrogen-doped carbon, tantalum, titanium, zirconium, iridium, platinum, and niobium or a nitride, a carbide, a carbonitride, and an oxide thereof on the substrate;

c) heating the coated substrate;

d) contacting the heated substrate with a flowing hydrogen-containing gas stream to thereby provide a multiplicity of carbon-containing nanotubes covalently bonded to the coated substrate, the nanotubes comprising a sidewall having a length extending to first and second ends, wherein a substantial number of the nanotubes are covalently bonded to the substrate at only their first end exhibiting relatively low polarization with respect to the second, free end, and wherein if there are nanotubes covalently bonded to the substrate at both their first and second ends, the sidewall of those nanotubes exhibits relatively low polarization with respect to the first and second ends; and

e) wherein with the electrode imbedded in body tissue in a functional manner, electrical energy transfers through the substrate, the catalyzing coating and then from exposed portions not covalently bonded to the coating of the multiplicity of nanotubes to the

body tissue in a low energy loss manner suitable for an implantable electrode.

12. The method of claim 11 including heating the coated substrate to a temperature of about 350°C to about 1,150°C.

13. The method of claim 11 including cooling the nanotube coated substrate in hydrogen prior to use.

14. A method of providing an implantable electrode, comprising the steps of:

a) providing a substrate;

b) providing nanotubes mixed with a binder precursor selected from chloroiridic acid, chloroplatinic acid, titanium (IV) chloride, zirconium (IV) chloride, niobium (V) chloride, and tantalum (V) chloride in a solvent;

c) contacting the binder precursor to the substrate;

d) converting the binder precursor to a coating on the substrate having a multiplicity of nanotubes covalently bonded thereto, the nanotubes comprising a sidewall having a length extending to first and second ends, wherein the nanotubes are either covalently bonded to the substrate at only their first end or they are covalently bonded to the substrate at both their first and second ends so that the sidewall of the nanotubes exhibiting relatively low polarization with respect to the covalently bonded end or ends is directly contactable by body tissue; and

d) wherein with the electrode imbedded in body tissue in a functional manner, electrical energy transfers through the substrate, the catalyzing coating and then from exposed portions not covalently bonded to the coating of the multiplicity of nanotubes to the body tissue in a low energy loss manner suitable for an implantable electrode.

15. The method of claim 14 including heating the binder precursor coated substrate in either an oxidizing or an inert atmosphere.

16. The method of claim 14 including heating the binder precursor coated substrate at a temperature of about 300°C to about 500°C.

17. The method of claim 14 including heating the binder precursor coated substrate for a time ranging from about 30 minutes to about 3 hours.

18. The method of claim 14 including heating the chloroiridic acid binder precursor in an oxidizing atmosphere to provide the nanotubes adhered to an iridium oxide binder coated on the substrate.

19. The method of claim 14 including heating the chloroplatinic acid, titanium (IV) chloride, zirconium (IV) chloride, niobium (V) chloride, and tantalum (V) chloride binder precursors in an inert atmosphere to provide the nanotubes adhered to a binder of platinum, titanium, zirconium, niobium, and tantalum, respectively, coated on the substrate.

20. A method for providing an implantable electrode, comprising the steps of:

a) providing a substrate;

b) coating a carbonaceous catalytic material on the substrate;

c) heating the carbonaceous coated substrate;

d) contacting the heated substrate with a flowing hydrogen-containing gas stream to thereby provide a multiplicity of carbon-containing nanotubes covalently bonded to the carbonaceous coated substrate, the nanotubes comprising a sidewall having a length extending to first and second ends, wherein a substantial number of the nanotubes are covalently bonded to the substrate at only their first end exhibiting relatively low polarization with respect to the second, free end, and wherein if there are nanotubes covalently bonded to the substrate at both their first and second ends, the sidewall of those nanotubes exhibits relatively low polarization with respect to the first and second ends; and

e) wherein with the electrode imbedded in body tissue in a functional manner, electrical energy transfers

through the substrate, the catalyzing coating and then from exposed portions not covalently bonded to the coating of the multiplicity of nanotubes to the body tissue in a low energy loss manner suitable for an implantable electrode.

21. The method of claim 20 including heating the carbonaceous coated substrate to a temperature of about 350°C to about 1,150°C.

22. The method of claim 20 including sputtering the carbonaceous catalytic material on the substrate.

23. The method of claim 20 including providing the sputtered carbonaceous catalytic material as nitrogen-doped carbon.

24. The method of claim 20 including providing the nitrogen in the nitrogen-doped carbon at a concentration of about 1 to about 57 atomic percent.

25. A method for providing an implantable electrode, comprising the steps of:

a) providing a substrate;

b) coating a catalytic material selected from the group consisting of carbon, nitrogen-doped carbon, tantalum, titanium, zirconium, iridium, platinum, and niobium or a nitride, a carbide, a carbonitride, and an oxide thereof on the substrate;

c) subjecting the coated substrate to a plasma assisted chemical vapor deposition process containing a flowing hydrocarbon-containing gas stream to thereby

provide a multiplicity of carbon-containing nanotubes covalently bonded to the coated substrate, the nanotubes comprising a sidewall having a length extending to first and second ends, wherein a substantial number of the nanotubes are covalently bonded to the substrate at only their first end exhibiting relatively low polarization with respect to the second, free end, and wherein if there are nanotubes covalently bonded to the substrate at both their first and second ends, the sidewall of those nanotubes exhibits relatively low polarization with respect to the first and second ends; and

d) wherein with the electrode imbedded in body tissue in a functional manner, electrical energy transfers through the substrate, the catalyzing coating and then from exposed portions not covalently bonded to the coating of the multiplicity of nanotubes to the body tissue in a low energy loss manner suitable for an implantable electrode.

26. The method of claim 25 including utilizing microwave excitation in the plasma assisted chemical vapor deposition process.

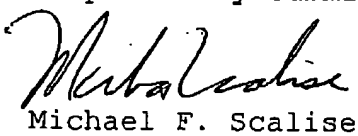
Evidence Appendix

There is no evidence submitted pursuant to Sections 1.130, 1.131 and 1.132 of the Codified Patent Rules.

Related Proceeding Appendix

There are no related proceedings.

Respectfully submitted,



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July 7, 2006

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Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).

FEE TRANSMITTAL
For FY 2006

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT	($)	500.00

Complete If Known	
Application Number	10/719,632
Filing Date	November 21, 2003
First Named Inventor	O'Brien et al.
Examiner Name	L. Faulcon, Jr.
Art Unit	3762
Attorney Docket No.	31611.0035

METHOD OF PAYMENT (check all that apply)

☐ Check ☑ Credit Card ☐ Money Order ☐ None ☐ Other (please identify): _____

☐ Deposit Account Deposit Account Number: _____ Deposit Account Name: _____

For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

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FEE CALCULATION (All the fees below are due upon filing or may be subject to a surcharge.)

1. BASIC FILING, SEARCH, AND EXAMINATION FEES

	FILING FEES		SEARCH FEES		EXAMINATION FEES		
		Small Entity		Small Entity		Small Entity	
Application Type	Fee ($)	Fee ($)	Fee ($)	Fee ($)	Fee ($)	Fee ($)	Fees Paid ($)
Utility	300	150	500	250	200	100	
Design	200	100	100	50	130	65	
Plant	200	100	300	150	160	80	
Reissue	300	150	500	250	600	300	
Provisional	200	100	0	0	0	0	

2. EXCESS CLAIM FEES

Fee Description	Fee ($)	Small Entity Fee ($)
Each claim over 20 (including Reissues)	50	25
Each independent claim over 3 (including Reissues)	200	100
Multiple dependent claims	360	180

Total Claims _____ - 20 or HP = _____ x _____ = _____ Extra Claims / Fee ($) / Fee Paid ($)

HP = highest number of total claims paid for, if greater than 20.

Indep. Claims _____ - 3 or HP = _____ x _____ = _____ Extra Claims / Fee ($) / Fee Paid ($)

HP = highest number of independent claims paid for, if greater than 3.

Multiple Dependent Claims — Fee ($) _____ Fee Paid ($) _____

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

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4. OTHER FEE(S)

	Fees Paid ($)
Non-English Specification, $130 fee (no small entity discount)	
Other (e.g., late filing surcharge): Filing a brief in support of an appeal	500.00

SUBMITTED BY			
Signature	Michael Scalise	Registration No. (Attorney/Agent) 34,920	Telephone 716-759-5810
Name (Print/Type)	Michael F. Scalise		Date July 10, 2006

This collection of information is required by 37 CFR 1.136. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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